US010070211B2

(12) **United States Patent**
Fan et al.

(10) **Patent No.: US 10,070,211 B2**
(45) **Date of Patent: Sep. 4, 2018**

(54) **DIGITAL VOICE PROCESSING METHOD AND SYSTEM FOR HEADSET COMPUTER**

(71) Applicant: **Kopin Corporation**, Westborough, MA (US)

(72) Inventors: **Dashen Fan**, Seattle, WA (US); **Jang Ho Kim**, San Jose, CA (US); **Yong Seok Seo**, Palo Alto, CA (US); **John C. C. Fan**, Brookline, MA (US)

(73) Assignee: **KOPIN CORPORATION**, Westborough, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/318,235**

(22) Filed: **Jun. 27, 2014**

(65) **Prior Publication Data**

US 2015/0006181 A1 Jan. 1, 2015

Related U.S. Application Data

(60) Provisional application No. 61/841,276, filed on Jun. 28, 2013.

(51) **Int. Cl.**
H04R 1/06 (2006.01)
G10L 99/00 (2013.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04R 1/08*** (2013.01); ***G10L 99/00*** (2013.01); ***H04R 1/005*** (2013.01); *H04R 2201/003* (2013.01)

(58) **Field of Classification Search**
CPC H04R 1/08; H04R 1/05; H04R 2201/003; G10L 99/00
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,091,936 A * 2/1992 Katznelson H04H 20/103 348/462
5,243,659 A * 9/1993 Stafford A42B 3/303 381/110

(Continued)

FOREIGN PATENT DOCUMENTS

EP	2 445 228	4/2012
WO	WO 03/059005	7/2003
WO	WO 2011/097226	8/2011

OTHER PUBLICATIONS

John J. H. Oh, Full Digital Amplifier for Mobile and Handheld Devices, AES 29th International Conference, Seoul, Korea, Sep. 2-4, 2006.*

(Continued)

Primary Examiner — Edwin S Leland, III
(74) *Attorney, Agent, or Firm* — Hamilton, Brook, Smith & Reynolds, P.C.

(57) **ABSTRACT**

The invention is a multi-microphone voice processing SoC primarily for head worn applications. It bypasses the use of conventional pre-amp voice CODEC (ADC/DAC) chips all together by replacing their functionality with digital MEMS microphone(s) and digital speaker driver (DSD). Functionality necessary for speech recognition such as noise/echo cancellation, speech compression, speech feature extraction and lossless speech transmission are also integrated into the SoC. One embodiment is a noise cancellation chip for wired, battery powered headsets and earphones, as smart-phone accessory. Another embodiment is as a wireless Bluetooth noise cancellation companion chip. The invention can be used in headwear, eyewear glass, mobile wearable computing, heavy duty military, aviation and industrial headsets and other speech recognition applications in noisy environments.

20 Claims, 8 Drawing Sheets